Multidetector Computed Tomography for Retrospective, Noninvasive Staging of Liver Fibrosis

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KEYWORDS

• MDCT • Liver fibrosis • Liver segmental volume ratio (LSVR)
• Liver surface nodularity • CT texture analysis • Elastography

KEY POINTS

- Noninvasive assessment of hepatic fibrosis currently includes laboratory tests, clinical data, and cross-sectional imaging, particularly magnetic resonance or ultrasound elastography techniques.
- Computed tomography (CT) is fast, accessible, robust, and commonly used for a variety of abdominal indications. CT metrics are captured retrospectively without special equipment.
- Subjective assessment of morphologic changes of liver disease is relatively insensitive, particularly for early or intermediate stages of fibrosis; however, new CT tools or metrics allowing quantitative assessment of these features may improve detection.
- Liver segmental volume ratio (Volume of segments I-III/Segments IV-VIII) quantifies regional hepatic volume changes and allows detection of significant fibrosis ($\geq$METAVIR fibrosis stage 2).
- Quantification of liver surface nodularity on CT can accurately identify intermediate stages of fibrosis and was the best performing metric in a multiparametric model.

INTRODUCTION

Liver disease resulting in hepatic fibrosis is a common problem that is important to identify early to halt progression and, with continued improvements in therapy, potentially reverse the process. Assessing the degree of hepatic fibrosis is useful in

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determining treatment and prognosis.[1,2] Liver biopsy remains the gold standard in diagnosing and staging hepatic fibrosis; however, this method is invasive, expensive, and may be subject to sampling error.[3,4] Pathologic scoring of fibrosis is commonly reported as fibrosis stage (F)-0 through F4, corresponding to absent (F0), early or mild (F1), significant (≥F2), advanced (≥F3), and cirrhotic (F4) levels. However, there has been a growing interest in noninvasive staging of liver disease, with great strides made in the last decade, particularly with respect to medical imaging. A variety of noninvasive strategies exists, ranging from serum laboratory tests to techniques assessing liver stiffness such as magnetic resonance (MR) and ultrasound (US) elastography.[2] Although not traditionally used in the assessment of hepatic fibrosis, computed tomography (CT) can also be a valuable tool in the assessment of liver disease.

NONINVASIVE ASSESSMENT OF LIVER DISEASE

Laboratory Tests or Biochemical Markers

The first and easiest step in assessing liver disease is often the use of routine serologic biochemical tests.[1] Several different models or scoring systems combining blood-based laboratory values exist and rely on evaluation of common functional alterations of liver to identify significant fibrosis or cirrhosis.[5–8] Two of the most frequently used scoring systems, extensively studied in viral hepatitis, include AST to platelet ratio index (APRI) (platelets, aspartate aminotransferase (AST)) or Fibrosis 4 (FIB-4) (age, platelets, AST, alanine aminotransferase (ALT)) scores.[9,10] These scores may suggest significant fibrosis (≥F2, area under the curve [AUC] 0.63–0.86) but cannot stage individual fibrosis levels and typically cannot detect mild or early stages of fibrosis that are at risk for progression.[9,10] Serum markers measuring products of extracellular matrix synthesis, or degradation products and enzymes that regulate production have been found to be increased in patients with advanced fibrosis, which has led to the development of new and potentially improved serum assays.[5,6,8,11] Again, the main limitation of these tests is the inability to identify early stages of fibrosis. In addition, these more advanced assays may not be available in all clinical laboratories.[1]

Imaging Techniques: Magnetic Resonance and Ultrasound Elastography

Use of elastography techniques for measuring liver stiffness has increased for assessment of hepatic fibrosis. Transient US elastography (eg, Fibroscan, Echosens, Paris France) is widely used in Europe.[12] Mechanical vibrations are transmitted to tissues, which induces a shear wave that propagates in the liver. The measured velocity of wave propagation is directly related to liver tissue stiffness (shear waves travel faster in stiffer tissues).[1] This technique has shown moderate performance in detecting significant fibrosis (≥F2) with an AUC of approximately 0.72 to 0.91 in patients with Hepatitis C virus (HCV).[12–16] Another US-based elastography technique generates shear waves by focusing an acoustic radiation force inside the tissue of interest.[17] This technique allows real-time conventional hepatic US for window placement of elastography and shows similar or improved performance compared with transient elastography, with AUCs for significant fibrosis (≥F2) of 0.85 to 0.87 in meta-analyses.[16,18,19] The downside to US assessment is that it can be limited by the acoustic window (often performed from an intercostal approach) or by patient body habitus.

MR elastography uses a similar technique to transient US elastography, in which shear waves are generated by applying a mechanical vibration to the surface of the body. However, with MR elastography, these shear waves are generated continuously and are tracked by acquiring images with motion sensitive phase-contrast sequences used to create wave images and subsequent elastograms.[17] MR elastography